The Emergence of Organic Light Emitting Diodes (OLEDs) as a Future Solid State Light Source

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Organic Light Emitting Diodes (OLEDs) and Light Emitting Diodes (LEDs) are evolving as the next generation of light sources. Presently, both sources are being rigorously explored for application in the display and signal market. The size and high profit margins of this market provide the stimulus for manufacturers to make major investments in these technologies. As a secondary market, OLEDs and LEDs are also being considered for application in general illumination.

This article will focus on the emergence of OLEDs, the fundamentals of the technology, and the technical barriers that currently limit the application of the technology. The article will place special emphasis on the future application of OLEDs to general illumination.

In principal, OLEDs and LEDs operate in a similar manner. An electric field impressed across the device causes electrons and holes to flow from the cathode and anode, respectively. When the electrons and holes combine they form an excited state that radiates. In both sources the potential applied across the device is not significantly larger than the band gap of the radiative transition. Hence, the search is for systems that do not have large inherent parasitic losses and thus will yield very efficacious light sources.

Since the search for an efficacious OLED must begin with the device, this discussion will first define the construction of the device and the different approaches being pursued to overcome current technical barriers.

The discussion will also describe performance attributes of the OLED devices; these are significantly different from those of LED devices. For example, LEDs can sustain much higher current densities compared to those of OLEDs, and are therefore more intense light sources for similar efficiencies. OLEDs operate at much lower current densities; consequently, they require much larger surface areas to generate the same total luminous flux. This difference in luminous intensity complements the different market segments that these two new technologies will assume in the future. The OLEDs are best suited to applications in the display market as self-luminous flat panel displays, and in the general illumination market as diffuse sources which will ultimately replace fluorescent lighting.

Finally the article will discuss the versatility of these sources, in both the spatial and temporal senses. The devices can be made of materials which can be shaped to forms and operated in new ways, providing exciting new opportunities for improving our living spaces.